NOK

TENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
pf04390/PC		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IE 00/00012	28/01/2000	29/01/1999
Applicant		
SUPARULES LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 04 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readble form.

   ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☒ **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

   ☒ as suggested by the applicant.

   ☐ because the applicant failed to suggest a figure.

   ☐ because this figure better characterizes the invention.

   ☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 00/00012

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01R11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 426 360 A (MARAIO ROBERT A ET AL) 20 June 1995 (1995-06-20) abstract column 1, line 34 - line 63 column 2, line 16 -column 3, line 44 column 8, line 14 -column 9, line 58	1-5,7
Y	figures 2,3,5,8	6,8

X	EP 0 689 057 A (EATON CORP) 27 December 1995 (1995-12-27) abstract column 2, line 24 - line 55 figures 2-4,7	1

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2000	23.06.00

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lopez-Carrasco, A

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 00/00012

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 338 542 A (MATSUSHITA ELECTRIC IND CO LTD ;KANSAI ELECTRIC POWER CO (JP)) 25 October 1989 (1989-10-25) abstract column 6, line 10 - line 30 figures 1,4 ---	6
Y	DE 197 12 239 C (SIEMENS AG) 27 August 1998 (1998-08-27) abstract figures 1-6 -----	8

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INTERNATIONAL SEARCH REPORT

national application No.
PCT/IE 00/00012

Box I Ob ervations wh re certain laims were found unsearchabl (Continuation f item 1 f first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet(s)

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-9

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-9

Power meter that can be retro-fitted to existing mains installations.

2. Claims: 10-13

A probe exhibiting less interference from external sources.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IE 00/00012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5426360 A	20-06-1995	NONE	
EP 0689057 A	27-12-1995	US 5548523 A	20-08-1996
		AU 683736 B	20-11-1997
		AU 2028195 A	04-01-1996
		BR 9502253 A	23-01-1996
		CA 2152220 A	21-12-1995
		CN 1126852 A	17-07-1996
		JP 8015334 A	19-01-1996
		NZ 272152 A	24-04-1997
		ZA 9504944 A	07-02-1996
EP 0338542 A	25-10-1989	JP 1270678 A	27-10-1989
		JP 1270679 A	27-10-1989
		JP 2034170 C	19-03-1996
		JP 7052200 B	05-06-1995
		DE 68907979 D	09-09-1993
		DE 68907979 T	11-11-1993
		KR 9606865 B	23-05-1996
		US 4999571 A	12-03-1991
DE 19712239 C	27-08-1998	WO 9843099 A	01-10-1998
		EP 0970383 A	12-01-2000

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
pf04390/PC/DB/mr		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IE00/00012	28/01/2000	29/01/1999
International Patent Classification (IPC) or national classification and IPC G01R11/04		
Applicant SUPARULES LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
18/08/2000	13.06.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Rath, R Telephone No. +49 89 2399 8950

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00012

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-19 as originally filed

Claims, No.:

1-16 as originally filed

Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

   ☐ the entire international application.

   ☒ claims Nos. 10-16.

because:

   ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

   ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

   ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

   ☒ no international search report has been established for the said claims Nos. 10-16.

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

   ☐ the written form has not been furnished or does not comply with the standard.

   ☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

   ☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☐ all parts.

☒ the parts relating to claims Nos. 1-9.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-9
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-9
Industrial applicability (IA)	Yes:	Claims	1-9
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

se s parat sheet

Re Item IV

Lack of unity of invention

1). The separate inventions/groups of invention are:
a) power meter
b) a probe

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive st p or industrial applicability; citations and explanations supporting such statem nt

2). Reference is made to the following documents:

D1: US-A-5 426 360
D2: EP-A-0 689 057
D3: EP-A-0 338 542
D4: DE 197 12 239 C

3). The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document):
an electrical energy meter comprising an electrically (insulating) housing (Fig.1: 12)
for securing two mains cables (16) ...
for piercing the insulation sheath (Fig. 5: 50)
sensing means for providing an output corresponding to the current (Fig. 2,3)
means for calculating (Fig. 8).

The subject-matter of claim 1 therefore differs from this known D1 in that:
it states expressly the use of an insulating housing.

This is a simple workshop selection which falls within common considerations of a man skilled in the art and thus cannot be considered as involving an inventive step (Article 33(3) PCT).

4). D2 discloses also a power meter with toroidal coils (33) and penetrates the insulation(53). Similarly no details are given on the housing (12).

However, the circuit breakers mentioned (column 3, lines 57,58) usually use a plastic and thus insulating housing.

Therefore claim 1 also lacks an inventive step versus D2.

5). Dependent claims 2-9 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of an inventive step, the reasons being as follows:
the features are either disclosed by D1, D3, D4 or fall within common considerations of a man skilled in the art (claim 9).

Re Item VII

Certain defects in the international application

6). Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

The applicant has not provided reasons why the claim should not be in the two-part form. Neither did he clearly indicate in the description which features of the subject-matter of claim 1 is already known from document D1; see the PCT Guidelines, III-2.3a.

7). The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

8). Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1-D4 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

9). On the third claims pages two claims are also numbered 15 and 16 and thus not consistent with claims pages 1,2 (claims 1-16).

Furthermore said claims (15,16) contain a reference to the drawings. According to Rule 6.2(a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here.

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) pf04390/PC

Box No. I TITLE OF INVENTION

Electrical Energy Meter

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Suparules Limited
9 Technological Park
Castleroy
County Limerick
Ireland

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: ie

State *(that is, country)* of residence: ie

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Michael McCormack
9 Technological Park
Castletroy
County Limerick
Ireland

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: ie

State *(that is, country)* of residence: ie

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Mr David Brophy
F.R. KELLY & CO.
27 Clyde Road
Ballsbridge
Dublin 4
Ireland

Telephone No.
+353 1 660 2111

Facsimile No.
+353 1 668 2844

Teleprinter No.

☒ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Mr Thomas Sorenson
Darien
Annacotty
County Limerick
Ireland

This person is:

- [ ] applicant only
- [x] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: ie

State *(that is, country)* of residence: ie

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [x] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:

- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:

- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:

- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

[ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☒ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

☒ **AE** United Arab Emirates
☒ **AL** Albania .....
☒ **AM** Armenia .....
☒ **AT** Austria .....
☒ **AU** Australia .....
☒ **AZ** Azerbaijan
☒ **BA** Bosnia and Herzegovina .....
☒ **BB** Barbados
☒ **BG** Bulgaria .....
☒ **BR** Brazil .....
☒ **BY** Belarus .....
☒ **CA** Canada
☒ **CH and LI** Switzerland and Liechtenstein
☒ **CN** China .....
☒ **CR** Costa Rica .....
☒ **CU** Cuba .....
☒ **CZ** Czech Republic .....
☒ **DE** Germany .....
☒ **DK** Denmark .....
☒ **DM** Dominica
☒ **EE** Estonia .....
☒ **ES** Spain .....
☒ **FI** Finland .....
☒ **GB** United Kingdom
☒ **GD** Grenada
☒ **GE** Georgia .....
☒ **GH** Ghana .....
☒ **GM** Gambia
☒ **HR** Croatia .....
☒ **HU** Hungary .....
☒ **ID** Indonesia
☒ **IL** Israel .....
☒ **IN** India .....
☒ **IS** Iceland
☒ **JP** Japan .....
☒ **KE** Kenya .....
☒ **KG** Kyrgyzstan .....
☒ **KP** Democratic People's Republic of Korea .....
☒ **KR** Republic of Korea .....
☒ **KZ** Kazakhstan .....
☒ **LC** Saint Lucia
☒ **LK** Sri Lanka
☒ **LR** Liberia
☒ **LS** Lesotho .....
☒ **LT** Lithuania
☒ **LU** Luxembourg
☒ **LV** Latvia
☒ **MA** Morocco .....
☒ **MD** Republic of Moldova .....
☒ **MG** Madagascar .....
☒ **MK** The former Yugoslav Republic of Macedonia .....
☒ **MN** Mongolia
☒ **MW** Malawi .....
☒ **MX** Mexico .....
☒ **NO** Norway
☒ **NZ** New Zealand .....
☒ **PL** Poland .....
☒ **PT** Portugal .....
☒ **RO** Romania
☒ **RU** Russian Federation .....
☒ **SD** Sudan
☒ **SE** Sweden
☒ **SG** Singapore
☒ **SI** Slovenia .....
☒ **SK** Slovakia .....
☒ **SL** Sierra Leone .....
☒ **TJ** Tajikistan .....
☒ **TM** Turkmenistan .....
☒ **TR** Turkey .....
☒ **TT** Trinidad and Tobago .....
☒ **TZ** United Republic of Tanzania
☒ **UA** Ukraine .....
☒ **UG** Uganda .....
☒ **US** United States of America .....
☒ **UZ** Uzbekistan .....
☒ **VN** Viet Nam .....
☒ **YU** Yugoslavia .....
☒ **ZA** South Africa .....
☒ **ZW** Zimbabwe .....

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

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item (1) 29.01.99	S990061			
item (2) 16.07.99	S990607			
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This international application contains the following **number of sheets**:

request	: 5
description (excluding sequence listing part)	: 19
claims	: 4
abstract	: 1
drawings	: 5
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FEE CALCULATION SHEET

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Date stamp of the receiving Office

Applicant's or agent's file reference pf04390/PC/DB/sb

Applicant

SUPARULES LIMITED

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2. SEARCH FEE . . . . . EUR 945.00 S

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PATENT COOPERATION TREATY

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(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BROPHY, David
F.R. Kelly & Co.
27 Clyde Road
Ballsbridge
Dublin 4
IRLANDE

Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
13 September 2000 (13.09.00)	
Applicant's or agent's file reference pf04390/PC	
International application No. PCT/IE00/00012	**International filing date** (day/month/year) 28 January 2000 (28.01.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
SUPARULES LIMITED 9 Technological Park Castleroy County Limerick Ireland	IE	IE
	Telephone No.	
	Facsimile No.	
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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

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	Facsimile No.	
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Date of mailing (day/month/year) 13 September 2000 (13.09.00)	
International application No. PCT/IE00/00012	**Applicant's or agent's file reference** pf04390/PC
International filing date (day/month/year) 28 January 2000 (28.01.00)	**Priority date** (day/month/year) 29 January 1999 (29.01.99)
Applicant MCCORMACK, Michael et al	

1. The designated Office is hereby notified of its election made:

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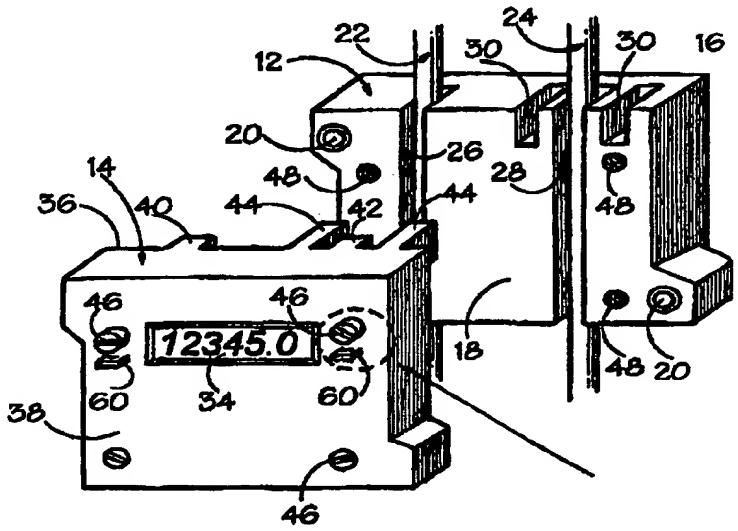

(57) Abstract

An electrical energy meter comprises an electrically insulating housing (10) for securing relative to least two main cables (22, 24) each having a conductive core surrounded by a sheath of insulating material. The housing includes respective electrical contacts for piercing the insulating sheath of each cable, a current probe for measuring current flowing in at least one of the cables, and circuit means for calculating and displaying electrical energy as a function of the voltage across the contacts and the output of the current probe. An improved current probe is employed comprising a series of Rogowski coils equally spaced around the circumference of a circle, with the gap between two adjacent coils permitting the current-carrying conductor to be introduced into the loop. An alternative current probe employs two such concentric loops of coils, enabling compensation for the effects of external current source pickup.

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ELECTRICAL ENERGY METER

This invention relates to electrical energy meters and to a current probe for use in such meters.

Standard electro-mechanical electrical energy meters have some or all of the following disadvantages.

They all consume a significant amount of power to operate. The IEC standard for class II meters is <2 watts. This power consumption amounts to between .25% to .5% of all power consumed. Losses due to metering are therefore substantial.

They have inertia problems when starting; therefore they must have a certain amount of power being drawn before they start to register.

They can only be installed by skilled personnel, and their installation is time-consuming. Electro-mechanical meters need to be fixed firmly to a flat surface in an upright position. In territories such as the former Soviet Union when metering is being installed in volume for the first time, the cost of installation of the electro-mechanical meters is high.

In conventional one wire current probes (see Fig. 1), a loop 1 of magnetic material surrounds a current carrying conductor 2 and a coil 3 comprising a large number of turns of wire is wound on the magnetic material 1. This type of probe relies on Ampere's Law which states that the integral of the magnetic field

around a closed loop surrounding a current source is equal to the current enclosed.

In a well designed probe of this kind the voltage or current induced in the coil 3 is not dependent on the position of the source current (conductor 2) within the cross section surrounded by the closed magnetic core 1. Furthermore, the ratio of pickup voltage or current from the current source 2 within the closed magnetic ring core 1, compared to the pickup from the same source when it is located outside the closed magnetic ring core is very large, e.g. >1000:1.

This ensures that stray pickup from interfering current sources which may be located close to the probe but outside the magnetic ring core do not affect the measurements obtained from the required source which is located inside.

One of the disadvantages of this type of probe however is its cost. The magnetic core must be manufactured in two or more sections to allow the core to be opened and closed so that the conductor can be inserted. In order to make an accurate measurement the alignment of the two sections on closing is critical, as is the requirement that even a small air gap between sections on meeting is not allowed.

US Patent No. 5,057,769 discloses a probe having a gap 4 (see Fig. 2) in a continuously wound non-magnetic core coil 5 to allow the insertion of the current source. In order to maintain the desirable features of the continuous winding closed non-magnetic core 5, an

effort is made to add back in the voltage component that would have been picked up by the coil turns which were removed to provide the air gap 4, by adding two individual multi-turn coils 6 at either side of the gap 4.

Even with the correct number of turns in these coils this is only partly successful. The voltage pickup of the probe is dependent on the location of the source conductor within the internal cross section of the coil. The closer the source current carrying conductor is to the gap or the windings, and the larger the gap, the greater the variation in pickup.

Furthermore, with this design, the pickup from sources in area 7 outside the core gap cross-section is no longer negligible and the pickup from an external current source increases as the gap increases, or as the external sources approach the gap. This can pose a serious limitation especially when measurements are being performed in a distribution box for example, where there may be a large number of conductors carrying various currents in a confined space.

It is an object of the invention to provide a low cost, low power meter which is quick and easy to install and which may, if desired, be retro-fitted to existing mains installations. In particular, it is an object to provide a meter which may be fitted easily to domestic power supplies.

It is a further object to provide an improved probe exhibiting less interference from external sources than

in the prior art, without resorting to expensive designs.

According to the present invention there is provided an electrical energy meter comprising an electrically insulating housing for securing relative to least two mains cables each having a conductive core surrounded by a sheath of insulating material, the housing including respective electrical contact means for piercing the insulating sheath of each cable to make contact with the core, sensing means for providing an output corresponding to the current flowing in at least one of the cables, and circuit means for calculating and displaying electrical energy as a function of the voltage across the contact means and the output of the sensing means.

In a further aspect, the invention provides a current probe for measuring current in a conductor, comprising a plurality of coils connected together in series in an arrangement which substantially surrounds the cable in which current is to be measured.

Preferably, said coils are substantially equidistantly spaced in the form of an open loop, with a gap being provided between two of the coils in the loop, said gap enabling introduction of the conductor into the interior of the loop.

In a particularly preferred current probe, the coils are arranged in two concentric loops of coils, each loop being connected in series, and each loop having a gap between two of the coils in the loop, said gaps

enabling introduction of the conductor into the interior of the concentric loops.

Preferably, in such an embodiment, there is also provided an electronic circuit for comparing the pickup from external sources experienced by each of the two loops and providing an output which compensates for such pickup, based on the respective dimensions of the loops.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is an illustration of a first known current probe arrangement;

Fig. 2 is an illustration of a second known current probe arrangement;

Fig. 3 is a perspective view of a meter according to the invention with the front plate removed;

Fig. 4 is a top plan view of the front plate of the meter of Fig. 5;

Fig. 5 is a horizontal cross-section through the meter;

Fig. 6 illustrates a security device for the meter;

Fig. 7 is a diagram of a current probe according to the invention schematically illustrating the arrangement of coils in the meter of Figs. 3-6;

Fig. 8 is a sectional plan view of a detail of the meter of Figs. 3-6 showing the arrangement of coils therein; and

Fig. 9 is a diagram of an alternative current probe according to the invention which can be incorporated in the meters of the invention.

In the following description, expressions of orientation are used for convenience only and are not intended to limit the orientation of the meter in use.

Referring to Figs. 3-5, an electrical energy meter is shown for measuring and displaying the amount of energy supplied by a pair of mains live and neutral cables 22, 24 respectively, each having an inner conductive core surrounded by an outer sheath of insulating material.

The meter comprises a housing 10 formed in two parts, herein referred to as a back plate 12 and a front plate 14, moulded from an electrically insulating plastics material. The back plate 12 is a solid block having a flat rear surface 16 and a shaped front surface 18. The back plate 12 has two holes 20 to receive fixing devices such as screws or bolts (not shown) which allow the back plate to be fastened with its rear surface 16 flat against a wall or other supporting surface (also not shown) behind the mains cables 22, 24. The latter are, in use, placed across the front surface 18 of the back plate 12 such that each lies in and along a respective one of a pair of parallel vertical guide channels 26, 28 in the surface 18. The front surface

18 also has a pair of recesses 30 disposed closely one on each side of the upper end of the channel 28 containing the neutral cable 24.

The front plate 14, which is hollow to contain a printed circuit board 32 and an LCD counter 34 to be described, has a shaped rear surface 36 and a substantially flat front surface 38. The rear surface 36 has a pair of parallel vertical ribs 40, 42 and a pair of parallel projections 44 disposed closely one on each side of the upper part of the rib 42. The ribs 40, 42 and projections 44 on the rear surface 36 are shaped and located such that they are substantially complementary to the channels 26, 28 and recesses 30 in the front surface 18 of the back plate 12.

In use, when the back plate 12 has been fixed to a wall or other support surface with the cables 22, 24 disposed in the channels 26, 28 as described, the front plate 14 is offered to the back plate 12 with the ribs 40, 42 in register with the channels 26, 28 respectively and the projections 44 in register with respective recesses 30, and the front plate is then pushed towards the back plate such that the ribs enter the channels and the projections enter the recesses. The front plate 14 is clamped to the back plate 12 in this position by means of four bolts 46 which pass through the front plate and engage respective screw-threaded inserts 48 embedded in the back plate, the bolts 46 being tightened until the rear surface 36 of the front plate comes to abut against the front surface 18 of the back plate.

As seen in Fig. 5, the width of each channel 26, 28 is substantially the same as the diameter of the respective cable 22 or 24, while the depth of each rib 40, 42 is less than the depth of the corresponding channel 26, 28 by a distance substantially the same as the diameter of the respective cable 22 or 24. Thus, when the two plates 12, 14 are clamped together as aforesaid, each cable 22, 24 is snugly accommodated in a respective vertical bore 50 of square cross-section in the housing 10.

Each rib 40, 42 has a respective electrical contact 52, Fig. 4, securely embedded therein, each contact having a pointed forward end 54 projecting centrally from the free end of the rib. Thus, when the front and back plates 12, 14 are clamped together as aforesaid, each forward end 54 of a contact 52 automatically pierces the insulating sheath of the corresponding cable 22 or 24 to establish electrical contact with the conductive core. In use, therefore, the contacts 52 tap the instantaneous voltage across the cables 22, 24.

In addition to the contacts 52 for tapping the voltage across the cables 22 and 24, the front plate 14 also contains one or more coils for sensing, by induction, the instantaneous current in the neutral cable 24 and providing an output signal corresponding to such current. In the illustrated, preferred embodiment of Figs. 3-5, such sensing is effected by a series of coils 56 (described in greater detail below with reference to Figs. 7-9) embedded in and behind the projections 44 so as to surround the cable 24 on three sides. However, the skilled person will appreciate

that the design of meter discussed above can employ any suitable current sensing means, while retaining the advantages of ease of manufacture and installation.

The voltage tapped by the contacts 52 and the output of the current sensing coils 56 are connected to an energy-calculating circuit (not shown) mounted on the printed circuit board 32. Such circuit may be of conventional design and is arranged to calculate, in known manner from the tapped voltage and the sensed current, the electrical energy in KWhrs supplied by the cables 22, 24. The circuit drives an LED counter 34 which displays the calculated result.

In order to prevent tampering with the meter, the head 46a, Fig. 6, of at least one of the bolts 46 projects from the front surface 38 of the front plate 14 and has a cross bore 58. Just below each such bolt there is a respective tab 60 projecting from and securely embedded in the front surface 38, each tab having a hole 62. A wire 64 passing through the bore 58 and hole 62 and sealed at 66 prevents the bolt 46 from being turned sufficiently to remove the front plate 14 from the back plate 12.

The arrangement of coils will now be described in more detail with reference to a current probe illustrated in Fig. 7.

The probe comprises a series of N (in this case N=7) identical Rogowski coils 56 equally spaced along the circumference of a circle.

The spacing between any pair of adjacent coils 56 may be used to insert a current conductor to be measured, such that the current-carrying conductor is partially surrounded by the circular array of coils. This arrangement suffers, to some extent, from the same effects as the probe of Fig. 2 (i.e. the voltage pickup of the probe is dependent on the location of the source conductor within the internal cross section of the coil, and the pickup from outside the core gap must be taken into account).

At this point it is useful to compare the performances of the probes shown in Figs. 2 and 7.

In the Fig. 2 design, the closer the current carrying conductor is to the gap or the windings the greater the variation in pickup. As expected, the larger the gap the larger the variation in pickup levels. However this variation can be kept within acceptable limits. For example variations of less than $\pm$ 3% may be obtained with gaps of about 1.6 cm if the source current conductor is confined to a rectangular area 8 (Fig. 2) which begins a distance D (approximately 10mm) from the centre of the gap and ends a distance C, (also approximately 10mm), from the continuous windings 5.

Using the design of Fig. 7 with the dimensions given above the variation in reading obtained may also be kept less than $\pm$ 3% if the current conductor is confined to the rectangular area 68 which is less than the width of the gap and stretches vertically from the dotted line located at distance D, where D=10mm, from the circumference diametrically opposite. This

performance is very similar to the probe design shown in Fig. 2.

However, using the design of Fig. 7, the error in measurement due to these effects gets smaller as the number N of individual coils increases.

As the number N of coils increases however, for a given diameter F of circle, the gap between individual coils decreases, as does the diameter of conductor that may be inserted. Preferably, one will use the maximum number of individual coils possible that still accommodates the largest conductor diameter required in the application. For example if the design requires a maximum source conductor diameter of 14mm and the coils are arranged in a circle having a diameter F=42.5mm, then the maximum number of individual coils that may be used is seven. This leaves space for individual coil widths G of 2mm and an enclosure thickness of 1mm.

A very important feature of the probe design is the pickup ratio or interference ratio R between the pickup from an external source 9 (see Fig. 2), at a distance x from the gap, and the pickup from the same source when it is located in the measurement area 8. This ratio R should be minimised.

For a typical well designed probe with the configuration of Fig. 2, Table 1 shows the calculated value of pickup ratio R, expressed as a percentage for increasing values of x expressed in mm. The dimensions of the continuous coil portion 15 of the probe are taken as 50mm long by 31mm wide in the calculations of

Table 1. These dimensions are typical for this type of probe.

R %	x mm
22	4
12	6
7	8
4	10
2.1	12
1.2	14
0.8	16
0.6	18
0.5	20
0.4	22
0.32	24
0.28	26
0.20	34

TABLE 1.

It can be seen from Table 1 that in order to maintain an error of less than 2% due to an interfering source of the same current magnitude as the source being measured, the distance x must be greater than about 12mm. Since the minimum value of D is 10mm in this design then the minimum spacing (x+D) between the interfering source and the source being measured must be greater than 22mm.

It is quite possible in the case of a distribution box, for example, that the interfering source current could be a factor of ten or more larger then the current being measured. For a factor of ten difference, the distance x to the source must be greater than 34mm in order to maintain a maximum error of less than 2% due to interference and thus the total separation between

measured and interfering sources would have to be greater than 44mm.

The pickup ratio R as defined above is shown in Table 2(a) for the probe of Fig. 7 having a diameter F of 42.5mm.

R %	x mm
20	4
13.3	6
8.6	8
5.6	10
3.7	12
2.54	14
1.7	16
1.2	18
0.87	20

F = 42.5mm
N = 7

Table 2(a)

If Table 1 and Table 2(a) are compared it is seen that for values of x less than 6mm, the system of Fig. 7 is slightly better than that of Fig. 2. However, as x increases beyond 6mm the system of Fig. 7 can be better by as much as a factor of 2 at x=18mm.

Fig. 8 shows a simple embodiment of such a coil arrangement in greater detail. In Fig. 8 one can see a portion of the back plate 12 and front plate 14 in the vicinity of rib 42, projections 44 , and neutral cable 24. It can be seen that neutral cable 24 is pierced by forward end 54 of contact 52, which is connected via a

voltage take-off conductor 60 to the PCB (not shown). The voltage between the live and neutral conductors is used to power the PCB measurement circuitry and the LCD display.

For simplicity, Fig. 8 shows a series of only five coils 56 arranged around the circumference of a circle, and connected in series. A gap between the two uppermost (as seen in Fig. 8) coils 56 admits neutral cable 24. The voltage generated in the series of coils is carried via a pair of conductors 58 to the PCB where the current within the neutral conductor is determined from the calibration of the coils 56.

The greater the number of equally spaced coils 56 and hence the smaller the gap between adjacent coils, the more sensitive the device will be, when this coil arrangement is used. Obviously, while only 5 coils are shown for simplicity in the Fig. 8 view, one will aim to maximise the number of coils consistent with the diameter of the conductor, by varying the design of the meter and thereby reducing the gap size.

Advantages of the meter described above are that it may be manufactured at low cost and is easy and quick to install to existing mains systems. It can be designed to use <40mwatts to power itself, being less than 2% of the power required by existing analog meters. It does not suffer from inertia and will register power at 50 times lower levels than existing meters.

Furthermore, by employing the current probe arrangement of the invention, the interference from external current sources can be reduced significantly.

Although the foregoing has described an embodiment where the meter is designed for use with a single pair of live and neutral cables, the invention is applicable to other mains systems, for example with three phase and one neutral cable.

The current probe can be improved by adding a second set of coils. To understand how this improvement occurs, the pickup ratio R is now examined for a set of seven coils identical to those discussed above for Fig. 7, but arranged on a 46.5mm circle rather than 42.5mm.

Table 2(b) displays the pickup ratio R for this arrangement of seven coils as a function of x. The distance x in this case is measured from the circumference of the larger circle.

R %	x mm
25.2	4
17	6
11	8
8	10
5.4	12
3.7	14
2.6	16
1.9	18
1.37	20

F = 46.5mm
N = 7

Table 2(b)

If both sets of seven coils each are present with their diameters differing by 4mm then an interfering source at a distance x from the circumference of the inner circle would be a distance (x-2)mm from the outer circumference.

If the ratio R picked up by the inner set at a distance x, as shown in Table 2(a), is compared with that picked up from the same interference location by the outer set, at a distance x-2, as shown in Table 2(b), it is observed that they differ in level by a factor of 2 approximately, with the outer set picking up twice the interference level of the inner set approximately. For convenience, Tables 2(a) and (b) are set out again, alongside one another:

R %	x mm
20	4
13.3	6
8.6	8
5.6	10
3.7	12
2.54	14
1.7	16
1.2	18
0.87	20

(a) F = 42.5mm
N = 7

R %	x mm
25.2	4
17	6
11	8
8	10
5.4	12
3.7	14
2.6	16
1.9	18
1.37	20

(b) F = 46.5mm
N = 7

Table 2.

For example, a source at x=10mm from the inner coils will exhibit a pickup ratio R=5.6% in the inner coil set. The same source is 8mm from the outer coils, in which a pickup ratio of R=11% is generated.

This factor 2 remains almost constant for different values of x. It is therefore possible, irrespective of the distance x, to cancel out a large proportion of the interference by subtracting approximately half the voltage picked up by the outer set from that picked up by the inner set. The factor of 0.5 is approximately the correct factor to use for these two particular coil set diameters each comprising seven identical coils.

For greater differences between the inner and outer coil set diameters there is an increase in the factor by which the interference pickup from the outer set is greater than that of the inner set. To compensate, therefore, one must subtract a smaller amount of the outer set pickup from that of the inner set in order to minimise interference. Best cancellation of interference at all distances x is obtained by minimising the difference between the diameters of both sets of coils that are used. Preferably the individual coil diameters (dimension "T" in Fig. 7) are reduced to assist in this regard.

The configuration of this minimum interference probe is shown in Fig. 9 together with a front end amplifier 70. The factor of pickup voltage from the outer set that is subtracted from the voltage pickup of the inner set is directly proportional to the ratio of resistor values R1/R2.

Table 3 shows the interference ratio R as a function of x for the coil arrangement of Fig. 9. In this table x is measured as the distance outwards from a point midway between the inner and outer circumferences. The results shown are for an inner diameter F1=42.5mm and an outer diameter F2 = 47.5mm. R1 is chosen to be 0.52 R2 in this design so that the effective input signal is the voltage pickup from the inner set minus 0.52 times the pickup from the outer set.

If one compares the values of pickup ratio R of Table 3 to those of Table 1 (i.e. comparing the configuration of Fig. 9 with that of Fig. 2) it is seen that the interference of this new probe is far less than that of the old probe at any distance x. In fact the rejection is a minimum factor of 3.7 lower at x = 4mm and increases to a factor of 33 lower at x = 20mm.

The configuration of Fig. 9 thus shows significant advantages over the configuration of Fig. 2 allowing the use of smaller probes with less interference.

R %	X mm
6	4
2.4	6
0.95	8
0.41	10
0.18	12
0.08	14
0.04	16
0.024	18
0.15	20

TABLE 3

In preferred probes according to the invention, therefore, the double coil arrangement of Fig. 9 may be used, subject to design variations in dimensions and numbers of coils.

A particularly preferred energy meter according to the invention incorporates, as its sensing means, the probe design of Fig. 9.

The invention is not limited to the embodiments described herein which may be modified or varied without departing from the scope of the invention.

Claims:

1. An electrical energy meter comprising an electrically insulating housing for securing relative to least two mains cables each having a conductive core surrounded by a sheath of insulating material, the housing including respective electrical contact means for piercing the insulating sheath of each cable to make contact with the core, sensing means for providing an output corresponding to the current flowing in at least one of the cables, and circuit means for calculating and displaying electrical energy as a function of the voltage across the contact means and the output of the sensing means.

2. An electrical energy meter according to claim 1, wherein the housing comprises first and second parts which are movable with respect to one another from a first position in which the cables may be introduced into the housing, to a second position in which the cables are secured relative to the housing.

3. An electrical energy meter according to claim 2, wherein the movement of the housing parts between the first and second positions causes the electrical contact means to automatically pierce the cables.

4. An electrical energy meter according to claim 2 or 3, wherein the housing parts are separate from one another when in the first position, and wherein the housing parts are secured together in the second position.

5. An electrical energy meter according to claim 2 or 3, wherein the housing parts are connected together in an open position to receive the cables in the first position, and are closed towards one another in the second position to secure the cables therein.

6. An electrical energy meter according to claim 2, wherein the first part is a back plate having means for receiving the cables and wherein the second part is a front plate which abuts against the back plate, with the cables held therebetween, one of said back plate and front plate being provided with said contact means, whereby the cables are squeezed onto said contact means when the back and front plates are brought together.

7. An electrical energy meter according to claim 2, further comprising means for locking the first and second housing parts together in the second position.

8. An electrical energy meter according to claim 7, further comprising security means which co-operate with the locking means to indicate if the locking means has been tampered with.

9. An electrical energy meter according to any preceding claim, wherein all of the power requirements of the meter are drawn from the mains cables.

10. A current probe for measuring current in a conductor, comprising a plurality of coils connected together in series in an arrangement which substantially surrounds the cable in which current is to be measured.

11. A current probe according to claim 10, wherein said coils are Rogowski coils.

12. A current probe according to claim 10 or 11, wherein said coils are substantially equidistantly spaced in the form of an open loop, with a gap being provided between the first and last coils in the loop, said gap enabling introduction of the mains cable into the interior of the loop.

13. A current probe according to claim 12, wherein said loop is a circle having a gap therein.

14. A current probe according to claim 10 or 11, wherein said coils are arranged in two concentric loops of coils, each loop being connected in series, and each loop having a gap between two of the coils in the loop, said gaps enabling introduction of the conductor into the interior of the concentric loops.

15. A current probe according to claim 14, further comprising an electronic circuit for comparing the pickup from external sources experienced by each of the two loops and providing an output which compensates for such pickup, based on the respective dimensions of the loops.

16. An electrical energy meter according to any one of claims 1-9, wherein the sensing means comprises a current probe according to any one of claims 10-15.

17. An electrical energy meter, substantially as hereinbefore described with reference to Figs. 3-9 of the accompanying drawings.

18. A current probe, substantially as hereinbefore described with reference to Figs. 7-9 of the accompanying drawings.

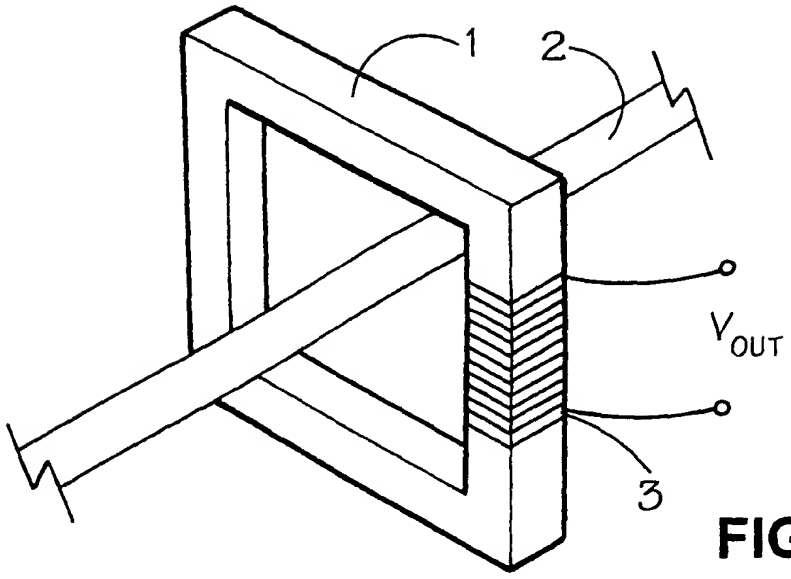


FIG.1.
PRIOR ART

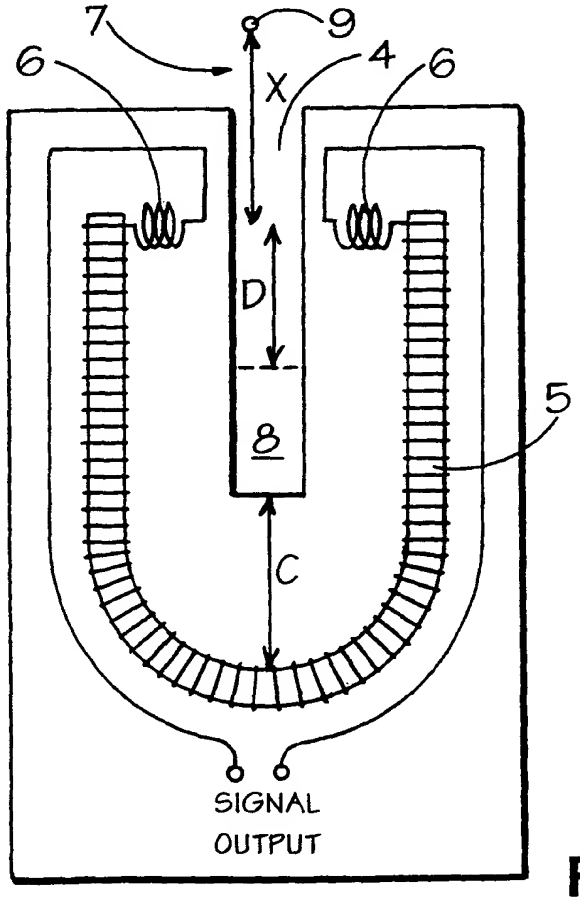
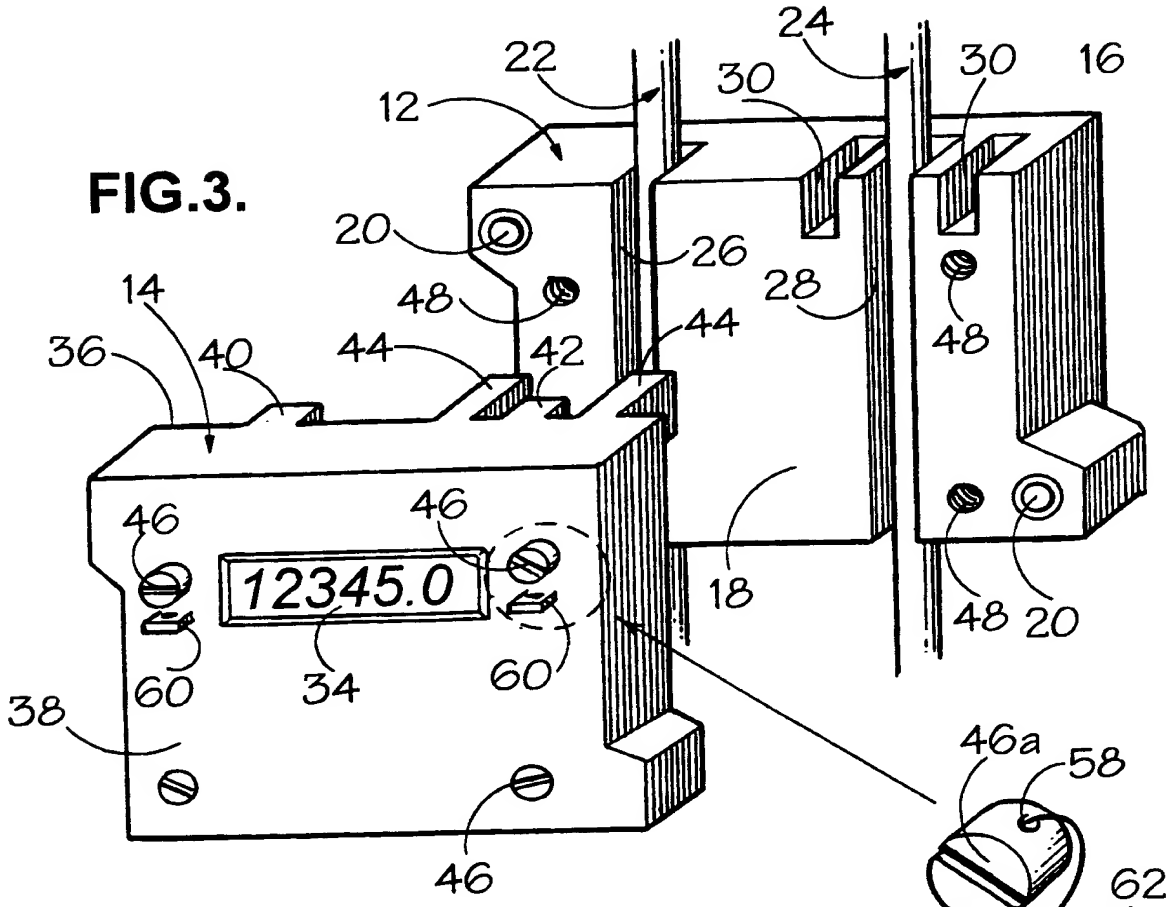


FIG.2.
PRIOR ART

FIG.3.



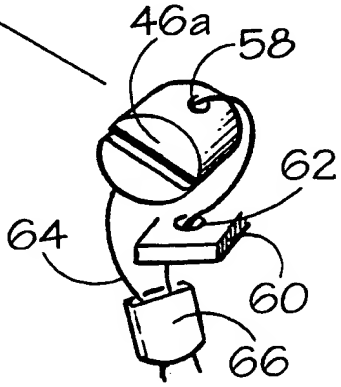


FIG.6.

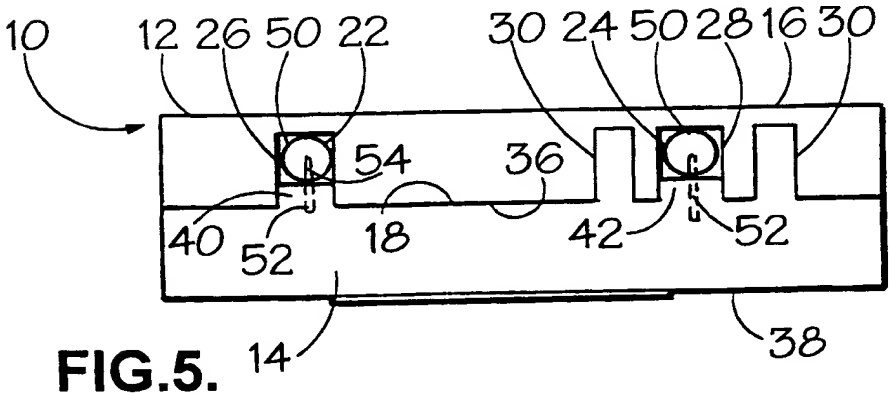


FIG.5.

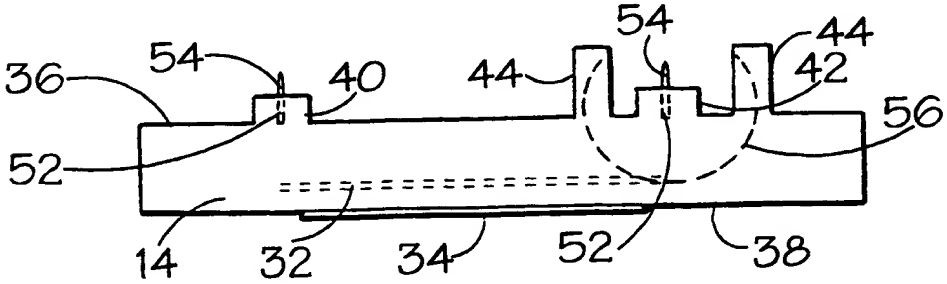


FIG.4.

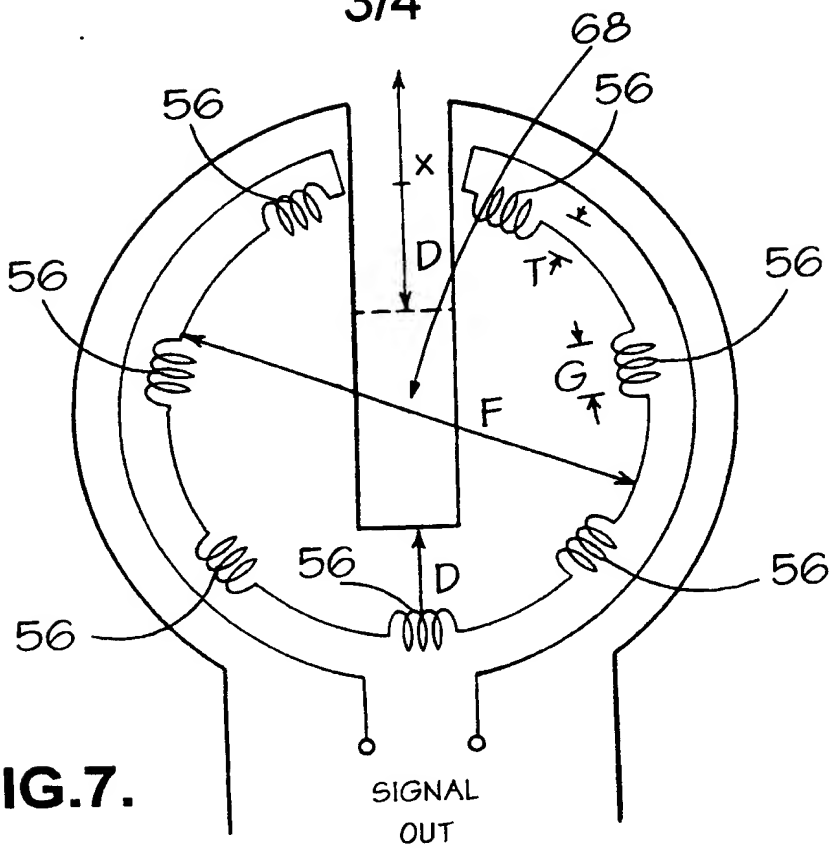


FIG.7.

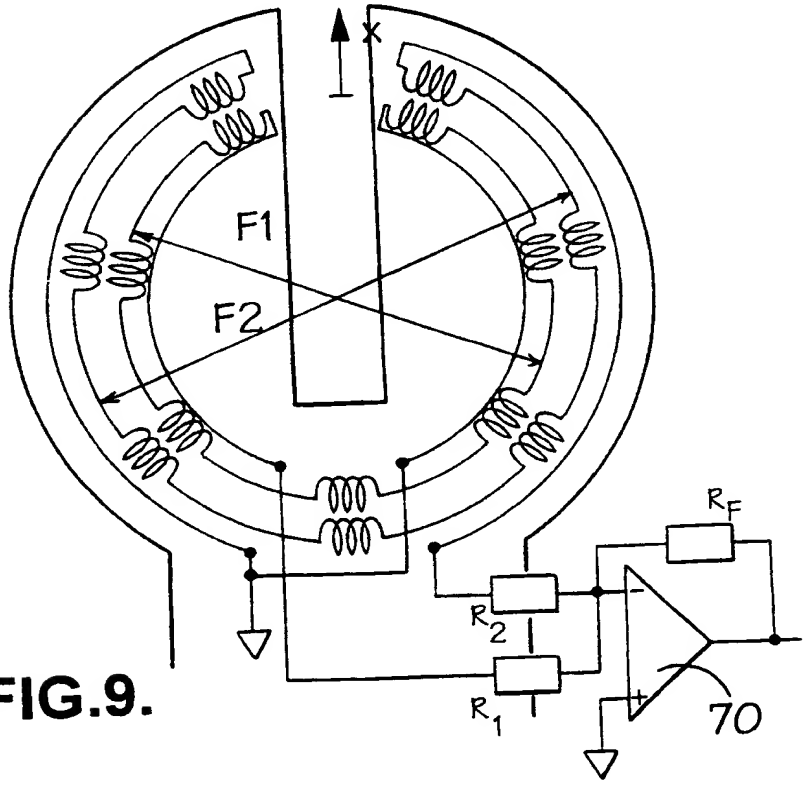


FIG.9.

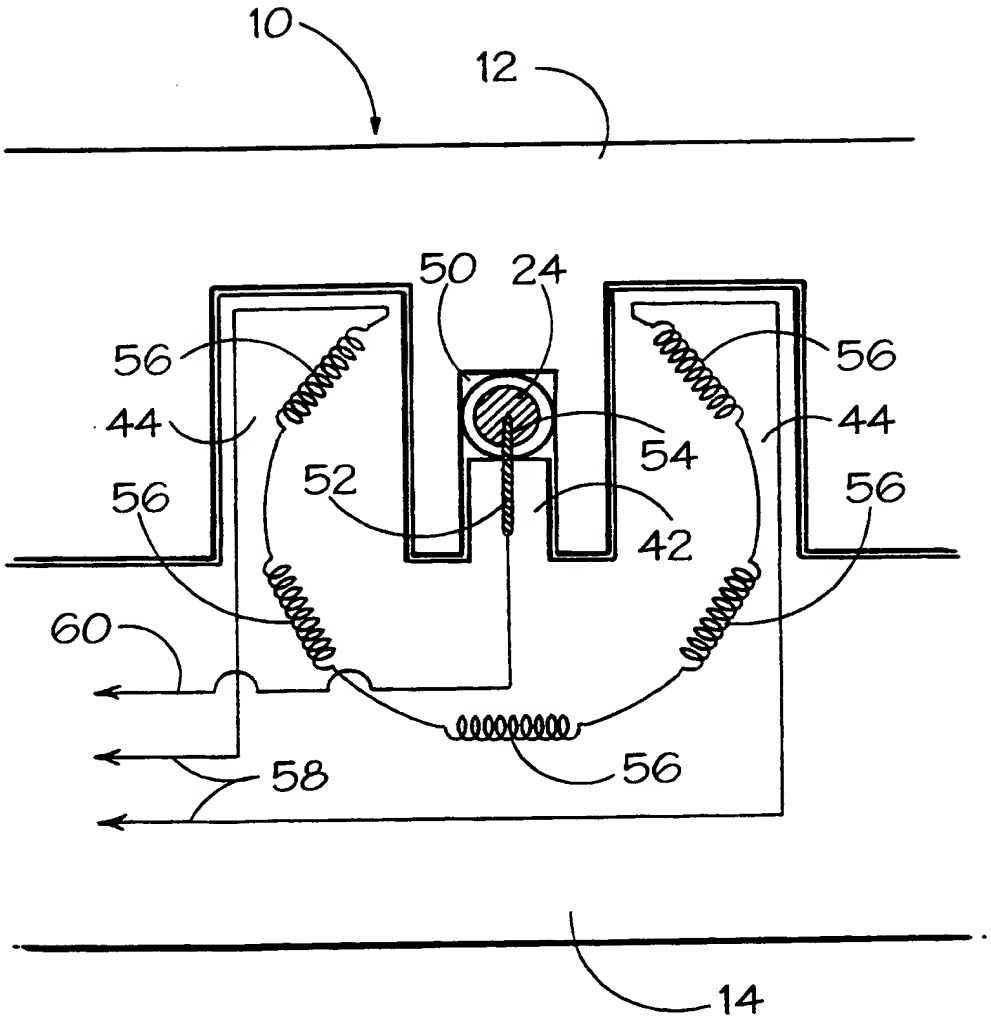


FIG.8.

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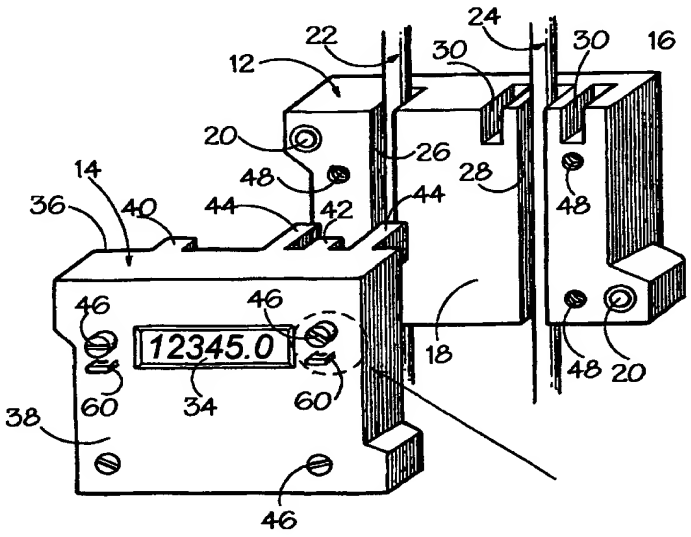
(54) Title: ELECTRICAL ENERGY METER



(57) Abstract: An electrical energy meter comprises an electrically insulating housing (10) for securing relative to least two main cables (22, 24) each having a conductive core surrounded by a sheath of insulating material. The housing includes respective electrical contacts for piercing the insulating sheath of each cable, a current probe for measuring current flowing in at least one of the cables, and circuit means for calculating and displaying electrical energy as a function of the voltage across the contacts and the output of the current probe. An improved current probe is employed comprising a series of Rogowski coils equally spaced around the circumference of a circle, with the gap between two adjacent coils permitting the current-carrying conductor to be introduced into the loop. An alternative current probe employs two such concentric loops of coils, enabling compensation for the effects of external current source pickup.

WO 00/45183 A3

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